TechShop
BUILD YOUR DREAMS HERE

Metal Lathe Safety and Basic Use - JET Lathe

COURSE # MIL102A

Version 1.3

The Fine Print

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Colophon

These materials were created electronically using Microsoft Word®. Art was produced using Adobe Illustrator®, Adobe PhotoShop® and SnagIt® for screen captures. The Arial® family of typefaces is used throughout these materials. These materials were written by TechShop Staff.

Course Synopsis

In this Safety and Basic Use class (SBU), you will learn how to perform basic operations on the metal lathe in a safe manner for yourself, those around you and the machine. This class will cover general machine shop safety, safety specific to the metal lathe, basic machine anatomy and function, safety for the machine itself, and several basic operations facing, turning, profiling, parting, and center drilling.

Time Required: 2 Hours

Tools Required

- ☐ Metal Lathe
- ☐ Facing and Turning Tool
- ☐ Profiling Tool
- ☐ Parting Tool
- ☐ Drill Chuck
- ☐ Letter X Splitpoint Drill Bit.
- ☐ Arbor Press

Materials Required

- ☐ ¾ Brass Rod Stock
- ☐ 1 neodymian magnet

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SAFETY

General Safety

- ◊ Eye protection is required **AT ALL TIMES** in the machine shop, regardless of whether machines are running. Street glasses are NOT adequate.
- ◊ Never talk to anyone while they are working on a piece of equipment
- ◊ Never leave a machine running while unattended
- ◊ Closed-toe shoes must be worn at all times

Equipment Specific Safety

- ◊ Loose clothing should not be worn around them Lathe. **ABSOLUTELY NO GLOVES** may be worn while operating the lathe: this includes latex, nitrile, vinyl, and similar gloves.
- ◊ Any jewelry on the hands or wrists must taken off while using the lathe.
- ◊ Long sleeves should be rolled up and secured past the elbows.
- ◊ Long hair must be pulled back and secured. Hair nets are available from the TechShop store.
- ◊ Watch out for loose clothing and other loose jewelry. Tie it back or remove it.
- ◊ **NEVER LEAVE THE CHUCK KEY IN THE CHUCK**, even for an instant! If you do, and the machine is turned on, the chuck key will be propelled at tremendous speeds out into the shop area and may strike someone or damage the machine. Always keep your hand on the chuck key when it is touching the chuck!
- ◊ Never lean on the machine. Always keep your weight back.
- ◊ Always measure your part while facing the chuck. Never reach over the chuck.
- ◊ Watch out for chips. The lathe may produce long ribbon-like metal shavings which can cut you or pull you into the machine. Consult with TechShop staff if you are continuously getting long hazardous chips.

Shop Etiquette

- ◊ Never talk to anyone while they are working on a piece of equipment
- ◊ Leave the area you are working in cleaner than when you arrived
- ◊ Never leave a machine running and unattended
- ◊ Begin final clean-up and store your project no later than 11:30 pm

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The Metal Lathe

It's an easy temptation to think that a lathe or milling machine is there to do about the same thing to a piece of metal that you might with a hacksaw or file, but more accurately, all by itself. This is not the case. Those big tools are super heavy, far stronger and a whole lot less sympathetic than you are. They are not only there to do what you could by hand, but also ready and willing to fling the entire work piece, tool, or you across the room.

Once you have access to a lathe, you can make anything you want with precision, right? Much as we might wish that to be true, it's fair to say that using a precision machine tool can be have as much of a "learning curve" as working with a computer or doing hand craft. Once you have a lathe, you can get busy learning and making things, growing your skill at each session.

Our goal with this Safety and Basic Use class is to help you understand the dangers of working around this piece of equipment and to get familiar with its most elementary operation. The last thing we want to do is test the limitations of our first aid kit!

All that said, the lathe is a machine that can be used all day, every day, with safety to both the user and the tool itself. While this class will give you the basic information you need to go to work on your own, learning as you make things for yourself, you might be a person who wants a more structured learning environment. To that end, we'll have classes that cover many more sophisticated techniques such as measurement and accuracy, working with irregular shapes, turning tapers and other shapes, boring and reaming, and even "single point" threading. Some good instruction can save you a lot of time learning technique. For example, threading on the lathe is difficult enough that even most lathe owners don't master it.

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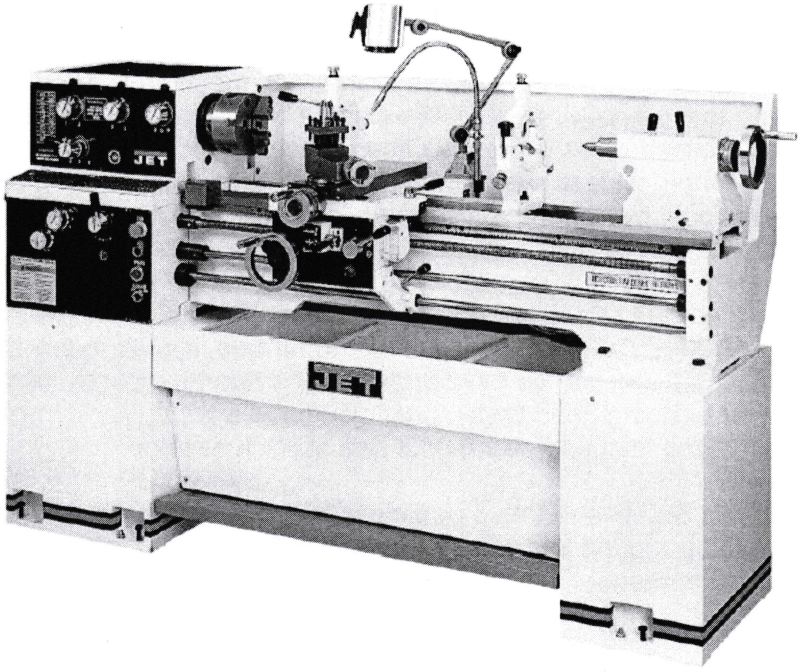

Equipment Controls

Speed Selector

This may differ from lathe to lathe. Most modern lathes use quick-change gears; however, older or simpler machines will use stepped pulleys and back gears.

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HeadStock

The headstock houses the main spindle, speed change mechanism, and change gears.

A Coolant On/Off Switch

B Power Indicator Light

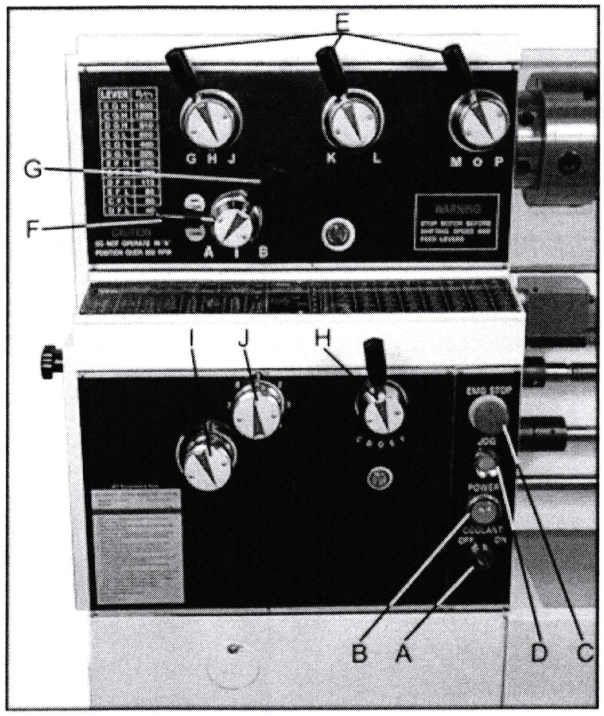
C Emergency Stop

D Jog Switch

E Headstock Gear Change Levers

F Leadscrew/Feed Rod Directional Lever

G Feed/Lead Selector Lever



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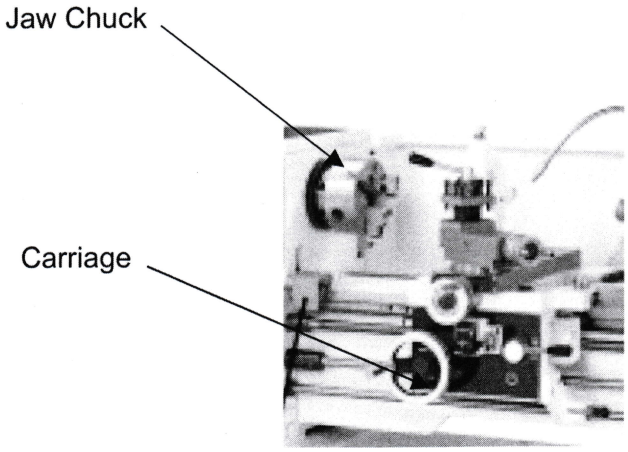
Jaw Chuck

This is the most common type of work holding device. The three jaws of the chuck are self centering and will tighten together. They can all be tightened by one nut however all nuts should be checked for tightness.

Carriage

The carriage includes all the adjustments that you will make for your cutter. The carriage wheel (A) moves the carriage back and tool to the left and the right on the ways. The cross Slide (B) moves the tool into and out of the piece or away-from or towards the operator. The compound slide (C) can be set to move the tool along any angle. It makes a "compound movement of both the carriage wheel and the cross slide. The tool post (D) is used to hold the tool and to position its angle in relation to the work. The tool holder (E) is used to house the tool. The threaded rod and knurled nut on top control the height of the tool.



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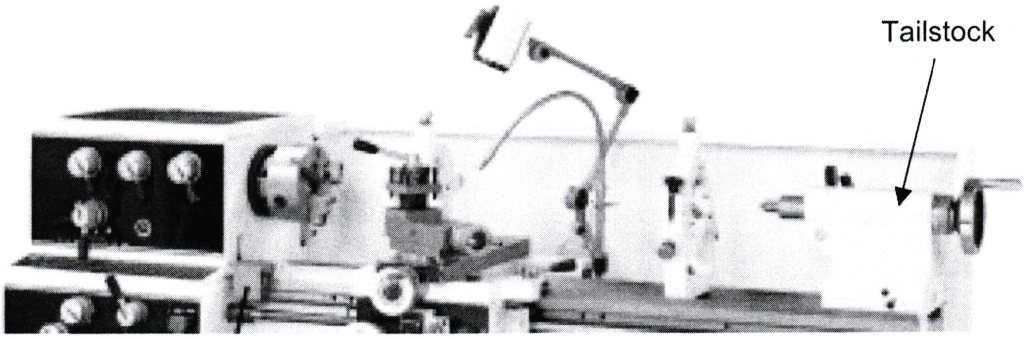
Tailstock

The tail stock is primarily used for two operations: Center drilling and work support. A Jacobs chuck is used to hold the drill for center drilling and a live center is used to support the work.



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BASIC OPERATION

Checking the Machine

Before getting started you should check over the lathe to notice any differences since the last time you used it, and to notice anything you might be unfamiliar with. Take care to inspect the chuck and tool holder. Also make sure to check that no automatic feed or threading was left engaged.

Metal Cutting Speeds

There are three parameters that define how fast material is removed:

1. **Surface Speed**: Rate at which metal comes into contact with the tool at the cutting point. Usually expressed in SFM: surface feet per minute.
2. **Feed Rate**: Rate at which the cutting point moves transverse to the stock, like an autofeed rate.
3. **Cut Depth**: How much material is being removed in a given pass.

Surface Speed

Surface speed is how fast the metal comes into contact with the tool at the cutting point. On a lathe, it is the rate at which the surface of the stock passes the cutting tool. This takes into account the diameter of the stock.

The general formula for a surface speed is as follows:

$$RPM = \frac{CS \times 4}{D}$$

where
CS = Cut Speed
D = diameter of stock (lathe) or diameter of cutting tool (mill), in **inches**
RPM = speed of the rotating part or tool, in **revolutions per minute**

NOTE: When facing a part on a lathe, to maintain a uniform surface speed, the RPM would need to go to infinity. When facing, select the speed based on the diameter at the outside surface. This will yield a slower speed than a diameter measured halfway through the stock, or at the center.

The cutting *Speed* is given as a set of constants that are available from the material manufacturer or supplier, the most common materials are available in reference books, or charts but will always be subject to adjustment depending on the cutting conditions.

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Cutting speeds for various materials (Based on a plain High Speed Steel cutter)

Material type	meters per min	feet per min
Steel (tough)	15 - 18	50 - 60
Mild steel	30-38	100-125
Cast iron (medium)	18-24	60-80
Bronzes	24-45	80-150
Brass (soft)	45-60	150-200
Aluminium	75-105	250-350

Feed Rate

Feed rate is how fast the tool moves relative to a fixed, stationary part. It is the autofeed rate when autofeed is used, and is usually measured in inches per minute on a mill, or inches per revolution on a lathe.

To translate between from inches per revolution to inches per minute on a lathe feed rate, divide the inches per revolution by the spindle speed in RPM.

$$\text{Feed Rate (IPM)} = \frac{\text{Cutting Speed (IPR)}}{\text{Spindle Speed (RPM)}}$$

Cut Depth

Cut depth refers to the amount of material being taken off per pass. It can vary from .100 inch for nylon (with a slow-ish feed rate) to .0005 or .001 for a final pass on a very hard metal like Stainless 304.

There is a handy online Turning Speeds and Feeds Calculator at:
http://www.custompartnet.com/calculator/turning-speed-and-feed

Chucking your work:

Open the jaws by turning one of the three nuts on the jaw with the chuck key. If one nut is marked, start with that one. When jaws are sufficiently open place stock material in chuck and tighten jaws. When tightening you should aim for more than snug; however, you do not want to apply to much force. Aim for "tight and secure." (Monkey tight, NOT gorilla tight)

Be sure enough stock is in the jaws for safe operation: the more material in the better. If you are only holding the work by the chuck make sure the material does not extend more than four times it's diameter outside of the chuck.

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Finding the Tool Height

To roughly determine whether your tool is at the correct height (you almost always want it dead center of the spindle) lightly pinch a stiff piece of metal such as a six-inch rule in between and the work. See which way the rule is pointing and adjust accordingly. A more exact measurement will be made by facing a piece.

Turning the Machine On

Take a minute to double check that everything is secure and that there are no loose pieces in the way, or that the lathe will not crash into itself. Note the placement of the emergency off switches. While standing out of the plane of the chuck start the lathe using appropriate handle. This is usually on the carriage.

Facing

To face the piece first find where the end of the piece is. With the machine running slowly and very lightly touch the tip of the tool off end of the piece (make sure it is on the side closest toward you). Once you touch off, zero the carriage wheel. Move the tool out. Set depth of cut accounting for backlash. With the machine on, begin slowly and evenly turning the cross slide, moving the tool to the center of the piece. If a nipple is left, check to see if the lathe bit is too high or too low and adjust accordingly.

Turning

This is very similar to facing except now we will reverse the axis. Reference the piece by touching off against the side of the piece. Zero the cross slide. Move the tool out and set the depth of cut with the cross slide, again, accounting for backlash. Begin slowly and evenly turn the carriage wheel, moving the tool to the right. Turn to desired length.

Profiling

First slow the R.P.M. Reference the tool against the piece in the exact manner as turning. Zero tool. Begin slowly and evenly turning the cross slide, moving the tool the in to the desired depth.

Parting

First, slow machine R.P.M. Make sure cutting tool is exactly perpendicular to the piece. Stand out of the plane of the chuck throughout the entire operation. This is exactly the same as profiling except we go all the way to the middle. The piece should fall easily to the bed. Do not retrieve it until the machine has stopped running.

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Center Drilling

Secure Jacobs chuck in tail stock by sliding it in with a light force. Put drill in and tighten from all three holes. Move tailstock so drill is close to the end of the piece. Lock tailstock to ways with long handle. Turn the back wheel to bring the drill up to touch the piece. Zero back wheel. Back off the piece and start lathe. Begin slowly and evenly turning the wheel to the desired depth. Depending on material, it is often a good idea while drilling to occasionally back the bit out of the hole to clear chips and reapply oil or coolant. This is especially important if you notice that chips have stopped coming out.

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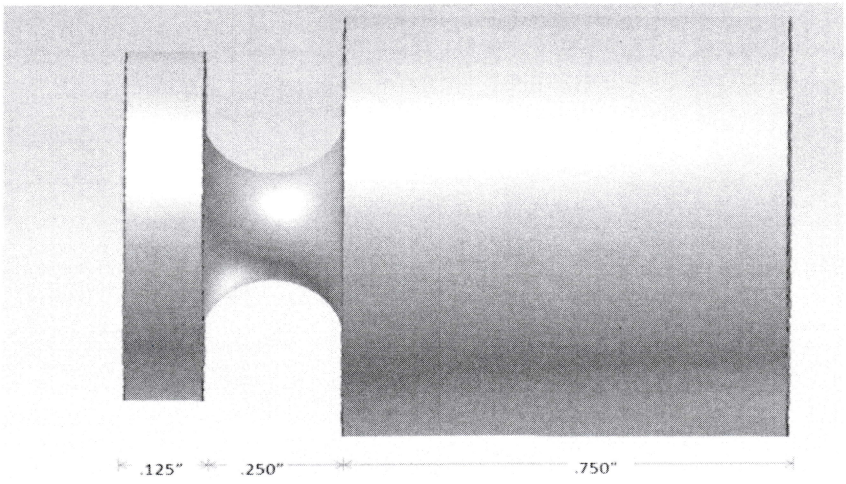
PROJECT DESCRIPTION

For this class, you will be given a piece of ¾" brass rod and a small neodymium magnet and you will make a brass refrigerator magnet by shaping the profile of round metal stock to make a body and a handle, and bore a hole to accommodate the press-fit magnet.

If you have **ANY** questions about any operation or task, be sure to ask your instructor or another TechShop staff member before proceeding.



Check the area around the Lathe – In a public workshop like TechShop, you MUST assume responsibility for ensuring that the machine you are going to work on and the surrounding area is safe and configured in a manner you expect and are familiar with.

Because these machines are shared by beginners to experts, you can not assume anything. You will need to become aware of the "typical" look and feel of the machine and the work area, and train yourself to notice changes since your last use. If changes are noticed, they must be understood and accounted for before beginning or continuing your work at the machine or workstation.

If it sounds or looks wrong, it probably is! Continually update your experience to include the ever-growing sensory awareness you gain as you use a given tool.

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Getting Started

When you first walk up to the lathe, be sure the configuration is what you expect. Inspect everything before you begin your work:

- Walk around the lathe to be sure there is nothing in the way of your feet. Also, check that the floor around the lathe is clean and clear of debris and lubricant.
- Check to see if anyone else is working in the area. Are they being safe? Will they impede you or your work on the lathe?

Check your tools, are they chipped or cracked? Replace any that are.

Turning your Part

Reference the Basic Operation section above for specifics of each step here:

1. Check the setup and make sure everything is in proper order.
2. Secure the brass rod in lathe, leaving no more than 3 inches extended.
3. Set the machine to 1100 RPM.
4. Roughly check the tool height using the piece of metal provided.
5. Adjust the tool angle for facing.
6. Turn on the machine and make the facing cut .025" deep.
7. Readjust tool height if necessary.
8. Center drill using letter X drill to at least .400"
9. Adjust the tool angle for square shoulder and make cut .025" deep by about 1 1/8" long.
10. Square up the profiling tool.
11. Choose the position to cut and profile to taste.
12. Square the parting tool to the material
13. Part the piece while leaving as much turned brass on the handle as possible.
14. Take the piece to the arbor press and press fit the magnet until it's flush.
15. Put it on your refrigerator at home and impress your friends!

Last Step: Cleanup

- Take out all tooling and return to appropriate location. If you have broken or damaged any tooling please bring do not return but speak to TechShop Staff or bring to the front.
- Clean up all of your chips any other chips in that area. Broom and Dustpan are by the door and you may use a vacuum
  Although the project does not require it, wipe up any coolant or lubricant and leave the dry machine.
- If you have used a special setup or have changed something so that it is no longer in its expected position leave it obviously out of position or find a staff member to help you correct this.

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COOL LINKS

http://www.mcmaster.com/ McMaster-Carr: metals, plastics, tools, industrial supplies, much more

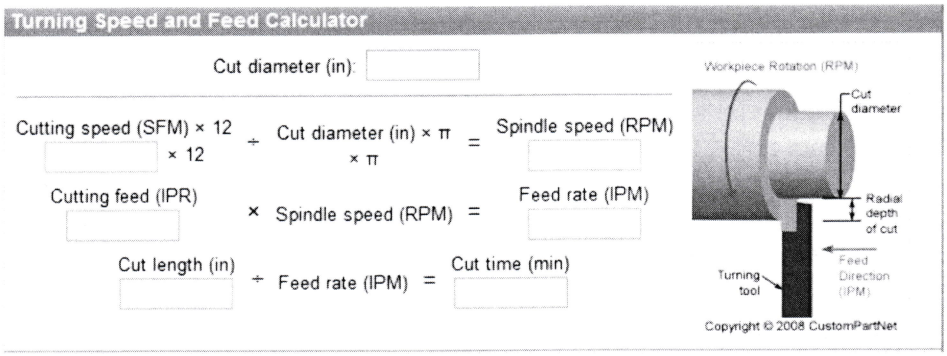
http://www.grainger.com/ Grainger Industrial Supply: tools, industrial supplies, much more

http://www.onlinemetals.com/ Online Metals.com: metals, plastics

http://www.use-enco.com/ Enco: metals, plastics, tools, industrial supplies, much more

http://www.whitney-tool.com/html/calculatorSpeedFeed.html Whitney Tool Company Speed and Feed Calculator

http://www.custompartnet.com/calculator/turning-speed-and-feed Custom Part Net Turning Speed and Feed Calculator



http://www.essortment.com/home/powertoolsuse_slzc.htm

http://www.nmri.go.jp/eng/khirata/metalwork/index_e.html

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SUPPLIES

LOCAL:

Dan-Mar Tool & Supply Co., in San Carlos, CA is a great local place to get End Mills, Center Drills, taps and dies.

WoodCrafters is a great place to get Endmills and all manner of woodworking tools and accessories.

ONLINE:

Micro100 Tool Corporation http://www.micro100.com/catalogs.html

Niagra Cutter http://www.niagaracutter.com/

HartLauer Bits: http://www.hartlauer-bits.com/

Onsrud Bits: http://www.onsrud.com/

Ekstrom-Carlson Bits: http://www.ekstromcutter.com

Quality One Engravers: http://www.q1engravers.com/

Enco http://www.use-enco.com

Be sure to pick up a copy of the TechShop Vendors List for Stock Suppliers from the front desk. A limited supply of endmills is available for purchase in the TechShop store.

WHAT'S NEXT?

After successfully completing this **MAC102 Metal Lathe SBU**, you might be interested in these classes:

MAC202 Metal Lathe 2 – Feeds and More Workholding
MAC203 Metal Lathe 2 – Tooling and Tool Grinding
MAC101 Milling Machine SBU
MAC201 Milling Machine 2

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